

**CLASSIFICATION, INDICATOR VALUE, AND
REGIONAL DIFFERENTIATION
OF BRYOPHYTE SPECIES
IN MINNESOTA'S CALCAREOUS FENS
and
VALIDATION OF CALCAREOUS FENS**

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CLASSIFICATION, INDICATOR VALUE, AND REGIONAL DIFFERENTIATION OF BRYOPHYTE SPECIES IN MINNESOTA'S CALCAREOUS FENS and VALIDATION OF CALCAREOUS FENS Update June 2004

Calcareous-Fen Indicators and Regional Differentiation

The following classification of bryophytes occurring in Minnesota's calcareous fens (CF) is based on a ranking of their importance value (IPV, Table 1). There are a total of 416 bryophyte species in Minnesota with detailed habitat information (fully surveyed ecotopes, see Janssens 2002), and 128 of these occur in calcareous fens. The total number of Minnesota ecotopes I have surveyed for bryophytes equals 1128, of which 124 are calcareous or extreme rich-fen habitats.

In addition, I have listed in Table 1 the regional relative abundance for each species. Three sub-regions are recognized for the prairie region (Aaseng et al. 1993): the NW, SW, and SE. The boreal and central region is not further differentiated here, because the distinction between the two areas is still being investigated (Aaseng, pers. comm.).

Figure 1 and perusal of the species list (Table 1) suggests to me that there is a reasonable division in **obligate and near-obligate** calcareous fen indicators (OB) with an IPV above 1.000 (17 species), **facultative** (FA) calcareous fen species with an IPV between 0.100 and 1.000 (15 species), and the remaining 96 species with an **occasional** (OC) occurrence and an IPV of <0.100. In Table 2 I have summarized the most frequent species and their regional preference.

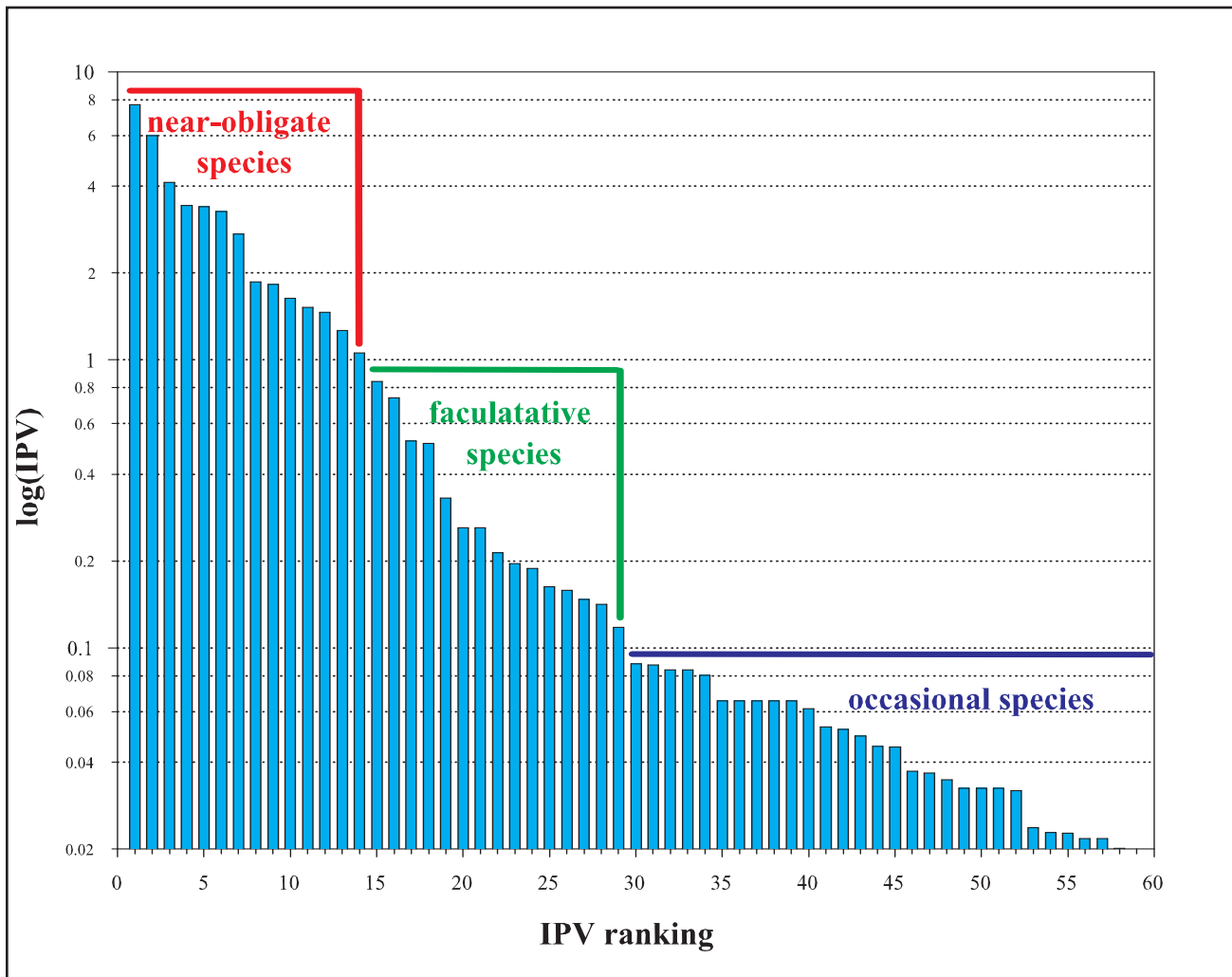


Figure 1. Most common bryophytes occurring in calcareous fens, ranked by descending IPV (to .02).

Table 1. Ranking of bryophyte species occurring in Minnesota's calcareous fens in order of descending IPV ($CF_{freq}^2 / nonCF_{freq}$). I designated species with an IPV >1.000 as **obligate and near-obligate** indicators, with an IPV between 0.100 and 1.000 as **facultative** indicators, and those with an IPV <0.100 as **occasional** species. The column labeled 'n CF' lists the number of calcareous-fen ecotopes in which the species occurs (out of a total of 124), 'n tot' the total number of surveyed ecotopes in Minnesota where the species has been found (out of a total of 1128). The values in the columns labeled 'CFB', 'CFPnw', 'CFPsw', and 'CFPse' are the relative abundances of the species in the extreme-rich fens of boreal (including central) forested region, and the calcareous fens of the NW, SW, and SE prairie sub-regions. The relative abundance is calculated as the % ratio of the number of collections for the species over the total number of all calcareous-fen bryophyte collections (n CFB = 928, CFPnw = 1806, CFPse = 1332, and CFPsw = 2339).

species name	IPV	n CF	n tot	boreal	-----prairie-----		
				CFB	CFPnw	CFPse	CFPsw
<i>Bryum uliginosum</i>	inf.	1	1		0.06		
<i>Catoscopium nigritum</i>	inf.	5	5	0.86	0.06		
<i>Paludella squarrosa</i>	inf.	3	3	1.29			
<i>Aneura pinguis</i>	7.6766	52	75	1.62	4.26	3.53	7.52
<i>Limprichtia cossonii</i>	6.0073	46	69	11.96	13.95	0.23	11.59
<i>Campylium stellatum</i>	4.1284	67	138	15.52	39.76	9.53	15.82
<i>Drepanocladus aduncus</i>	3.4381	74	178	4.09	2.60	14.04	16.84
<i>Bryum pseudotriquetrum</i>	3.3978	76	187	6.68	18.22	3.60	10.94
<i>Brachythecium rivulare</i>	3.2648	50	100	2.48	1.94	15.24	3.72
<i>Calliergonella cuspidata</i>	2.7283	31	54	2.05	0.61	2.33	5.69
<i>Scorpidium scorpioides</i>	1.8590	22	39	4.74	5.09		
<i>Cinclidium stygium</i>	1.8283	14	21	3.13			
<i>Moerckia hibernica</i>	1.6324	15	24	2.59	0.55		
<i>Calliergon trifarium</i>	1.5196	16	27	3.34	1.33		
<i>Plagiomnium ellipticum</i>	1.4570	59	215	2.91	1.38	14.19	7.48
<i>Campylium polygamum</i>	1.2612	26	61	4.09	1.05	1.88	3.33
<i>Fissidens adianthoides</i>	1.0535	22	52	4.85	0.50	1.13	
<i>Amblystegium varium</i>	0.8392	28	89	0.54	0.28	3.90	1.07
<i>Tomenthypnum nitens</i>	0.7384	21	60	2.37	0.72	0.15	
<i>Eurhynchium hians</i>	0.5224	12	30	0.43		1.50	
<i>Amblystegium serpens</i> var. <i>juratzkanum</i>	0.5119	14	39	0.86	1.72	0.53	3.51
<i>Brachythecium salebrosum</i>	0.3318	25	148	0.32	0.11	4.65	8.85
<i>Hamatocaulis lapponicus</i>	0.2612	2	3	0.32			
<i>Meesia triquetra</i>	0.2612	4	8	0.65			
<i>Helodium blandowii</i>	0.2137	12	56	0.22	0.39	0.53	0.21
<i>Pseudo-calliergon turgescens</i>	0.1959	3	6	0.11	0.89		
<i>Cratoneuron filicinum</i>	0.1889	9	37	0.86	0.89	2.10	
<i>Conardia compacta</i>	0.1632	5	15		0.06		0.43
<i>Hypnum lindbergii</i>	0.1582	19	168	0.86	0.72	2.85	0.09
<i>Campylium stellatum</i> var. <i>protensum</i>	0.1469	3	7		0.83		1.71
<i>Drepanocladus aduncus</i> var. <i>polycarpus</i>	0.1419	10	56	0.22	0.06	1.35	0.13
<i>Riccardia latifrons</i>	0.1175	6	26	0.97			

species name	IPV	n CF	n tot	boreal	-----prairie-----		
				CFB	CFPnw	CFPse	CFPsw
<i>Plagiomnium cuspidatum</i>	0.0882	17	231	0.54	0.22	1.73	0.09
<i>Drepanocladus sendtneri</i>	0.0871	2	5	0.11	0.22		
<i>Riccardia palmata</i>	0.0840	3	10	0.43			
<i>Hypnum pratense</i>	0.0837	10	88	0.22		2.18	0.09
<i>Leptodictyum humile</i>	0.0804	4	17			0.45	0.13
<i>Atrichum undulatum</i>	0.0653	1	2			0.08	
<i>Drepanocladus sordidus</i>	0.0653	1	2	0.11			
<i>Orthotrichum pumilum</i>	0.0653	2	6	0.11	0.06		
<i>Philonotis capillaris</i>	0.0653	1	2			0.08	
<i>Philonotis marchica</i>	0.0653	1	2			0.08	
<i>Leskea polycarpa</i>	0.0615	4	21	0.22	0.17	0.08	0.17
<i>Aulacomnium palustre</i>	0.0531	14	255	1.08	0.28	0.83	
<i>Bryum lisae var. cuspidatum</i>	0.0522	2	7			0.15	
<i>Hygroamblystegium tenax</i>	0.0495	5	38	0.11		0.45	
<i>Campyllum radicale</i>	0.0454	4	27	2.05	0.06	0.08	
<i>Calliergon giganteum</i>	0.0452	6	58	0.97	0.17		
<i>Platyhypnidium riparioides</i>	0.0373	2	9			0.23	
<i>Myurella julacea</i>	0.0367	3	19	0.32			
<i>Hamatocaulis vernicosus</i>	0.0348	4	34	0.75			
<i>Brachythecium digastrum</i>	0.0326	1	3			0.08	
<i>Dicranella varia</i>	0.0326	1	3				0.04
<i>Pterigynandrum filiforme</i>	0.0326	2	10	0.11		0.08	
<i>Amblystegium serpens</i>	0.0320	5	56		0.06	0.53	0.04
<i>Helodium paludosum</i>	0.0237	2	13			1.65	
<i>Brachythecium oedipodium</i>	0.0228	6	109	2.16		0.60	
<i>Campyllum chrysophyllum</i>	0.0227	4	50	0.22	0.17	0.23	
<i>Helodium blandowii var. helodioides</i>	0.0218	1	4			0.15	
<i>Ricciocarpos natans</i>	0.0218	1	4		0.06		
<i>Climacium americanum</i>	0.0201	2	15			0.23	
<i>Leskea gracilescens</i>	0.0163	3	39	0.43		0.15	
<i>Atrichum altecristatum</i>	0.0154	2	19			0.15	
<i>Brachythecium plumosum</i>	0.0154	2	19			0.15	
<i>Sphagnum warnstorffii</i>	0.0146	5	117	2.26			
<i>Brachythecium acuminatum</i>	0.0143	4	77			0.23	0.13
<i>Entodon seductrix</i>	0.0137	2	21			0.08	0.04
<i>Thuidium recognitum</i>	0.0137	5	124	0.97		0.08	
<i>Plagiothecium denticulatum</i>	0.0134	4	82	0.11	0.06	0.45	
<i>Cephalozia pleniceps ssp. sphagnorum</i>	0.0131	1	6	0.11			
<i>Fissidens dubius</i>	0.0131	2	22			0.30	
<i>Frullania inflata</i>	0.0131	1	6	0.11			
<i>Pylaisiella selwynii</i>	0.0122	3	51	0.32		0.08	
<i>Lophocolea heterophylla</i>	0.0118	5	143	0.11	0.11	0.30	0.04
<i>Marchantia polymorpha</i>	0.0104	2	27		0.06	0.15	
<i>Warnstorfia exannulata</i>	0.0104	2	27		0.06	0.08	

species name	IPV	n CF	n tot	boreal	-----prairie-----		
				CFB	CFPnw	CFPse	CFPsw
<i>Campylium hispidulum</i>	0.0095	3	65	0.54		0.08	
<i>Brachythecium oxycladon</i>	0.0093	2	30			0.15	
<i>Physcomitrium pyriforme</i>	0.0093	1	8			0.08	
<i>Sphagnum fuscum</i>	0.0084	4	129	0.65			
<i>Cephalozia connivens var. compacta</i>	0.0082	1	9	0.32			
<i>Philonotis fontana</i>	0.0082	1	9			0.53	
<i>Platydictya jungermannioides</i>	0.0082	1	9				0.09
<i>Rhizomnium gracile</i>	0.0082	1	9	0.11			
<i>Fissidens osmundioides</i>	0.0077	2	36	0.43			
<i>Leptodictyum riparium</i>	0.0077	2	36			0.08	0.04
<i>Sphagnum fimbriatum</i>	0.0069	2	40			0.75	
<i>Frullania oakesiana</i>	0.0065	1	11	0.11			
<i>Conocephalum conicum</i>	0.0061	2	45	0.11		0.08	
<i>Thuidium delicatulum</i>	0.0060	3	101			0.38	
<i>Plagiochila asplenoides</i>	0.0053	2	51	0.22			
<i>Brachythecium populeum</i>	0.0038	1	18			0.23	
<i>Mylia anomala</i>	0.0036	1	19	0.11			
<i>Tortella fragilis</i>	0.0036	1	19	0.22			
<i>Chiloscyphus pallescens</i>	0.0034	1	20			0.08	
<i>Polytrichum strictum</i>	0.0032	3	187	0.43			
<i>Atrichum oerstedianum</i>	0.0028	1	24			0.08	
<i>Distichium capillaceum</i>	0.0028	1	24	0.11			
<i>Leptobryum pyriforme</i>	0.0028	1	24	0.11			
<i>Taxiphyllum deplanatum</i>	0.0027	1	25			0.08	
<i>Sphagnum angustifolium</i>	0.0026	3	227	0.22		0.08	
<i>Brachythecium erythrorrhizon</i>	0.0026	2	104	0.11	0.06		
<i>Bryoerythrophyllum recurvirostre</i>	0.0023	1	30		0.06		
<i>Sphagnum capillifolium</i>	0.0018	2	146	0.11		0.15	
<i>Steeerecleus serrulatus</i>	0.0017	1	39			0.08	
<i>Climacium dendroides</i>	0.0015	2	175			0.75	
<i>Orthotrichum obtusifolium</i>	0.0015	1	45	0.11			
<i>Plagiomnium ciliare</i>	0.0014	1	47				0.17
<i>Sphagnum subsecundum s.s.</i>	0.0013	1	50			0.08	
<i>Sphagnum squarrosum</i>	0.0013	1	51			0.08	
<i>Cephalozia connivens</i>	0.0012	1	56	0.11			
<i>Orthotrichum elegans</i>	0.0011	1	61	0.11			
<i>Polytrichum commune</i>	0.0011	1	63			0.08	
<i>Brachythecium reflexum</i>	0.0010	1	64			0.08	
<i>Entodon cladorrhizans</i>	0.0010	1	66			0.08	

species name	IPV	n CF	n tot	boreal	-----prairie-----		
				CFB	CFPnw	CFPse	CFPsw
<i>Pleurozium schreberi</i>	0.0009	2	297	0.22			
<i>Pylaisiella polyantha</i>	0.0009	1	76		0.17		
<i>Dicranum undulatum</i>	0.0008	1	79	0.11			
<i>Ceratodon purpureus</i>	0.0008	1	83			0.08	
<i>Eurhynchium pulchellum</i>	0.0008	1	84			0.30	
<i>Sphagnum centrale</i>	0.0008	1	87			0.15	
<i>Anomodon minor</i>	0.0007	1	95	0.11			
<i>Hylocomium splendens</i>	0.0007	1	96	0.11			
<i>Calliergon cordifolium</i>	0.0007	1	101			0.15	
<i>Platygyrium repens</i>	0.0004	1	162	0.11			
<i>Ptilidium pulcherrimum</i>	0.0004	1	168	0.11			
<i>Dicranum polysetum</i>	0.0004	1	176	0.11			
<i>Sphagnum magellanicum</i>	0.0003	1	241	0.11			

Table 2. Summary of **OB** and **FA** calcareous-fen bryophyte species and their regional differentiation. The species listed have at least 2% or more of relative abundance based on number of collections in one of the regions. The relative abundance value for the region in which the species is dominant is highlighted.

species name	CFB	CFPnw	CFPse	CFPsw
<i>Fissidens adianthoides</i>	4.85	0.50	1.13	
<i>Campylium polygamum</i>	4.09	1.05	1.88	3.33
<i>Calliergon trifarium</i>	3.34	1.33		
<i>Cinclidium stygium</i>	3.13			
<i>Moerckia hibernica</i>	2.59	0.55		
<i>Tomenthypnum nitens</i>	2.37	0.72	0.15	
<i>Campylium stellatum</i>	15.52	39.76	9.53	15.82
<i>Bryum pseudotriquetrum</i>	6.68	18.22	3.60	10.94
<i>Limprichtia cossonii</i>	11.96	13.95	0.23	11.59
<i>Scorpidium scorpioides</i>	4.74	5.09		
<i>Brachythecium rivulare</i>	2.48	1.94	15.24	3.72
<i>Plagiomnium ellipticum</i>	2.91	1.38	14.19	7.48
<i>Amblystegium varium</i>	0.54	0.28	3.90	1.07
<i>Hypnum lindbergii</i>	0.86	0.72	2.85	0.09
<i>Cratoneuron filicinum</i>	0.86	0.89	2.10	
<i>Drepanocladus aduncus</i>	4.09	2.60	14.04	16.84
<i>Brachythecium salebrosum</i>	0.32	0.11	4.65	8.85
<i>Aneura pinguis</i>	1.62	4.26	3.53	7.52
<i>Calliergonella cuspidata</i>	2.05	0.61	2.33	5.69
<i>Amblystegium serpens var. juratzkanum</i>	0.86	1.72	0.53	3.51

Validation of Minnesota Calcareous Fens:

I have assigned an arbitrary value of 25 points to the **obligate and near-obligate** calcareous fen indicators, 5 points to the **facultative** species, and 1 point to the **occasional** species. Adding these species scores for each one of the calcareous fens of Minnesota with bryophyte surveys, the following validation is obtained (Table 3):

Table 3. Validation of the calcareous-fen localities of Minnesota based on the presence of bryophyte indicators. The *a priori* list of calcareous prairie fens studied has been provided by the Minnesota Department of Natural Resources (Aaseng *et al.* 1993 and pers. comm.) and the typing of the sites as calcareous fens is based on an independent assessment using vascular-plant indicators, and soil and water-chemistry characteristics (J.H. Leete and W.R. Smith, pers. comm.). Additional sites assessed as calcareous fens, added after the bryophyte-indicator has been set up (Table 1), are marked by an “*”. This table can be used as part of the assessment to evaluate non-listed sites for their identification and potential as calcareous fens. First a regional ranking (r) is given, and then an overall ranking (R) of all Minnesota calcareous fens.

Prairie NW			Prairie SW			Prairie SE		
r	value	locality	r	value	locality	r	value	locality
1	329	Ogema	1	235	Sioux Nation	1	253	Ottawa
2	243	Barnesville	2	186	Holte Prairie	2	249	Cannon River
3	241	Felton	3	185	Fairchild	3	202	Perched Valley
4	226	Gully	4	180	Zion	4	196	Wasioja
5	205	Sanders 18	5	175	Burke	5	192	Pheasants Forever
6	125	Holt Meadow	6	150	Kragero	6	191	McCarthy
7	105	Green Meadow	7	105	Altoona	7	169	Fort Snelling
8	105	Waubun	8	100	Adrian	8	156	Stewartville
Boreal & Central			9	89	Fort Ridgely	9	153	Savage
r	value	locality	10	80	Yonker	10	114	Nelson WMA
1	333	Lost River	11	76	Jeffers	11	113	Stonehedge
2	289	Sprague Creek	12	76	*Muller	12	106	Kennedy
3	263	Mulligan Lake	13	55	Sam Tutt	13	100	Nelson
4	252	Forest Grove	14	50	Fort Ridgely	14	100	Red Wing 21
5	251	Roseau River	15	31	Lost Timber	15	87	Perched Valley
6	232	Pine Creek				16	85	Mutchler
7	230	Net Lake				17	85	Wiscoy Valley East
8	186	Seminary				18	81	Eyota 13
9	182	Spring Hill				19	75	Houston 26
10	166	Bemis Hill				20	70	Sheldon 16
11	149	Iron Springs				21	59	Cannon Valley Trail
12	96	Sucker Creek				22	51	Nichols
13	75	Homolka				23	26	Black Dog
14	64	St. Croix						

all MN calcareous fens		
R	value	locality

1	333	Lost River
2	329	Ogema
3	289	Sprague Creek
4	263	Mulligan Lake
5	253	Ottawa
6	252	Forest Grove
7	251	Roseau River
8	249	Cannon River
9	243	Barnesville
10	241	Felton
11	235	Sioux Nation
12	232	Pine Creek
13	230	Net Lake
14	226	Gully
15	205	Sanders 18
16	202	Perched Valley
17	196	Wasioja
18	192	Pheasants Forever
19	191	McCarthy
20	186	Holte Prairie
21	186	Seminary
22	185	Fairchild
23	182	Spring Hill
24	180	Zion
25	175	Burke
26	169	Fort Snelling
27	166	Bemis Hil
28	156	Stewartville
29	153	Savage
30	150	Kragero

all MN calcareous fens		
R	value	locality

31	149	Iron Springs
32	125	Holt Meadow
33	114	Nelson WMA
34	113	Stonehedge
35	106	Kennedy
36	105	Altoona
37	105	Green Meadow
38	105	Waubun
39	100	Adrian
40	100	Nelson
41	100	Red Wing 21
42	96	Sucker Creek
43	89	Fort Ridgely
44	87	Perched Valley
45	85	Mutchler
46	85	Wiscoy Valley East
47	81	Eyota 13
48	80	Yonker
49	76	Jeffers
50	76	*Muller
51	75	Homolka Beach Ridge
52	75	Houston 26
53	70	Sheldon 16
54	64	St. Croix
55	59	Cannon Valley Trail
56	55	Sam Tutt
57	51	Nichols
58	50	Fort Ridgely
59	31	Lost Timber
60	26	Black Dog

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